4.1 HYDROLOGY: PRECIPITATION AND FLOW

Over the past six years, Los Angeles County has experienced weather patterns that have resulted in very diverse storm seasons. The two most significant seasons were the 1997-98 El Niño and the 1998-99 La Niña storm seasons.

The term El Niño refers to the disruption of the entire oceanic-atmospheric system in the tropical Pacific Ocean. This occurrence often causes a major departure from average temperatures and precipitation amounts on a global scale. During El Niño, the trade winds relax in the central and eastern Pacific and upwelling of deep colder ocean water is inhibited. Therefore, in the eastern Pacific, the water temperature rises. Increases in temperature in the central and eastern Pacific result in an increase of evaporation and convection, or thunderstorm activity. This activity can be observed, especially in the winter, as the subtropical jet stream flows from Southern California, through the Gulf Coast region.

The effects of the 1997-98 El Niño were the strongest observed for the past 40 years (National Oceanic and Atmospheric Administration). Rainfall associated with El Niño was greater later in the storm season as compared to previous years. The month of February of 1998 produced over fifteen inches of rain at the downtown Los Angeles raingage compared to the 110 year average of 3.17 inches for the same raingage. The previous year, the same raingage recorded only 0.06 inches of rain.

Furthermore, the total wet season runoff volume at the Los Angeles River station as of March, 1998, was nearly 300,000 acre-ft. By comparison, the 1996-97 storm season runoff volume at the same location was 58,309 acre-ft, approximately one-fifth.

In contrast, the 1998-99 storm season was considered a La Niña storm season. La Niña climatology is characterized by unusually cold ocean temperatures in the eastern equatorial Pacific that impact global weather patterns. La Niña tends to bring nearly opposite effects of El Niño to the United States. It often features drier than normal conditions in the Southwest in late summer trough the subsequent winter. La Niña conditions recur every few years and can persist as long as two years.

The month of February of 1999 produced only 0.4 inches of rain at the downtown Los Angeles raingage compared to the 110 year average of 3.17 inches for the same raingage. The same raingage during the El Niño season, by contrast, produced over 15 inches of rain. Similarly, the total rainfall for the 1998-1999 season at the Ballona Creek station was only 9.48 inches, and the total wet season runoff volume at the Ballona Creek station was 10,700 acre-ft. By comparison, the rainfall total during the previous storm season at this station was 28.28 inches and the runoff volume was 18,300 acre-feet.

Figures 4-20 and 4-21 respectively show the Los Angeles annual and monthly wet season rainfall at the downtown Los Angeles station.

Furthermore, the figure and table below display aerial weighted rainfall totals for the Los Angeles County by area. As expected, the San Gabriel and Santa Monica Mountains recorded the highest precipitation totals throughout the years while the dessert areas recorded the lowest. San Gabriel and San Fernando Valleys recorded very similar precipitation values. Again, it can be seen that El Niño season of 1997-98 produced twice as much rainfall as the seasonal normal, while La Niña season of 1998-99 recorded less than half the seasonal normal.

RAINFALL INDICES USING SELECTED STATIONS
for the period of October 1 through September 30

	Seasonal Normal (Inches)	94-95 Season (Inches)	95-96 Season (Inches)	96-97 Season (Inches)	97-98 Season (Inches)	98-99 Season (Inches)	99-00 Season* (Inches)
A. Coastal Plain	13.71	25.19	11.38	13.91	29.08	7.73	8.94
B. San Fernando Valley	17.62	35.01	13.22	18.58	39.56	10.35	15.64
C. San Gabriel Valley	17.64	29.61	14.35	17.17	35.63	8.53	13.55
D. San Gabriel Mountains	27.5	44.78	23.56	25.12	54.31	12.17	18.05
E. Little Rock, Big Rock	16.61	30.8	12.77	14.16	30.86	8.16	13.71
F. Santa Monica Mountains	19.96	40.14	14.81	18.02	45.72	10.17	16.82
G. Santa Clara	16.64	28.17	11.05	13.33	36.63	9.83	12.85
H. Desert	7.83	13.35	4.65	6.18	17.57	3.69	4.4
County**	15.65	27.27	11.69	13.72	33.01	8.02	11.17

Notes: * Rainfall from October 1, 1999 through April 30, 2000
** Seasonal Normal and Season sections of this line are derived from Areal Weighted Average.

Table 4-1 summarizes the hydrological data for each station for the 1994-95, 1996-97, 1997-98, 1998-99, and 1999-2000 seasons.

A collection of rainfall contour maps for the 1994-95, 1995-96, 1996-97, 1997-98, 1998-99, and 1999-2000 storm seasons are included in Appendix A.

Refer to Appendices of preceding annual Stormwater Monitoring Reports for hydrographs of monitored sites and rainfall contour maps for each storm event.

4.2 STORMWATER QUALITY

4.2.1 Overall Imperviousness

Overall watershed imperviousness has been linked to stormwater quality problems (Center for Watershed Protection, 1996). The following table gives the overall imperviousness of each of the major Watershed Management Areas under the 1996 Municipal Stormwater Permit:

Imperviousness of Watershed Management Areas

WATERSHED MANAGEMENT AREA	AREA, Sq. Mi.	OVERALL IMPERVIOUSNESS, %
Dominguez Channel/ L. A. Harbor	110	62
Ballona Creek	211	45
Los Angeles River	834	35
San Gabriel River	683	30
Malibu Creek	203	6
Santa Clara River	1029	5

Notes. - Values were calculated using the DPW GIS Pollutant Loading Model
- Land use distribution is based on 1993 SCAG data
- Imperviousness values for each land use were taken from the LACDPW Hydrology Manual, 1991

4.2.2 Bacterial Indicators

Los Angeles County has been monitoring a selection of bacterial indicators, including total coliforms and fecal bacteria (fecal coliforms, fecal streptococcus, and fecal enterococcus), at two of the mass emission monitoring stations (Ballona Creek and Malibu Creek) since the 1994-95 rainy season. Bacteria monitoring in 1994-95 and 1995-96 also involved land use sampling. All four of the mass emission monitoring stations currently required by the Permit (Ballona Creek, Malibu Creek, Los Angeles River, and San Gabriel River) have been sampled for bacteria since the 1995-96 storm season. Bacteria were not sampled at the Coyote Ck. station, which was not a requirement of the Permit, and land use sampling for bacteria was also not a requirement under the current Permit.

In addition to wet weather sampling, a number of dry weather samples were analyzed since 1994 to support other in-house studies, most notably for the low flow diversion projects at various locations along the shore line in Los Angeles County. Dry weather bacteria results are presented in Tables 4-5b and 4-5c.

Fecal bacteria are normal residents of the digestive tracts of humans and other warm-blooded animals. They are usually not pathogenic themselves but they can serve as indicators for the presence of potential pathogens (including bacteria, viruses, and protozoa that may cause human health problems) if contamination of surface waters with sewage had occurred. Fecal coliforms are a subgroup of the total coliform group.

Fecal coliforms, fecal streptococcus, and fecal enterococcus are three independent residents of the gastro-intestinal tracts of warm-blooded animals, and their distribution among warm-blooded species varies. Unfortunately, none of the bacteria is totally specific to humans, so none can serve as the ultimate indicator and warning signal for the presence of potential human pathogens.

Total coliforms and fecal bacteria (fecal coliforms, fecal streptococcus, and fecal enterococcus) were detected in all stormwater samples tested since 1994 at densities (or most probable number, MPN) between several hundreds to several million cells per 100 ml. Table 4-8 and Figure 4-4 show the wet weather sample results obtained between 1994 and 2000 for the different bacterial groups. The geometric mean (labeled as "log mean" for consistency with reports from other Los Angeles agencies) for each storm season is shown as one bar. Results are shown for the four mass-emission stations tested. Dry weather bacteria results are presented in Tables 4-5b and 4-5c.

The Malibu Creek station appears to have consistently lower counts than other mass emission stations and is consistently lower for all four groups of bacteria. There is no apparent pattern of differences between monitoring years, although the 1995-96 season appears to have higher mean densities than other years. At 75% of normal, this was not a particularly rainy season.

A study of the raw microbial data for wet weather and dry weather from 1994 to 2000 indicates the following:

- Every wet weather mass emission bacteria sample taken exceeded the public health criteria for indicator bacteria. All of the dry weather bacteria samples taken for the low flow diversion projects exceeded the public health criteria. Most of the dry weather mass emission bacteria samples taken exceeded the public health criteria. Wet weather flows contained bacteria densities at much higher levels (three to four orders of magnitude) than dry weather flows.

- Except for 1996-97, densities observed during the first storm of each rainy season were not necessarily higher than during consecutive storm events, suggesting that there was no consistent "first-flush" effect in these watersheds. Peak densities were observed at different times each year. In 1995-96, the peak density at all four mass emission stations and one land use station coincided with the peak storm of the season.

- Except for somewhat lower densities at Malibu Creek, there was no seasonal or regional consistency in cell densities. There was a very wide range of densities for all stations.

- There was one storm event, January 9, 1998, that yielded extremely high counts in all stations for all bacterial strains. The available data do not provide an explanation, or suggest whether this could be a contamination artifact.

- The 1996-97 season had one event, November 21, 1996, that yielded runoff with high counts in all stations for all species.

- During the 1998-99 season, the event of March 15, 1999 was associated with high bacterial counts for most stations and the events of March 25, 1999 and April 4, 1999 were associated with unusually low counts for most stations.

The following table gives the storm date when the peak fecal coliform reading was observed for that season:

Comparison of Storm Dates to Peak Fecal Coliform Dates

		1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000
Date of First Storm > 0.1”		10/04/94	12/13/95	10/29/96	11/10/97	11/08/98	11/08/99
Date of Largest Storm		01/07/95	02/20/96	01/20/97	02/21/98	04/11/99	03/03/00
Depth of Largest Storm (inches)		6.65	4.39	3.54	5.08	1.15	2.01
MONITORING STATION	Ballona Creek	01/10/95	02/20/96	10/29/96	01/09/98	02/09/99	02/10/00
	Malibu Creek	03/03/95	02/20/96	10/29/96	01/09/98	03/15/99	02/23/00
	Los Angeles River	N/A	02/20/96	11/21/96	01/09/98	03/15/99	02/23/00
	San Gabriel River	N/A	02/20/96	11/21/96	01/09/98	03/15/99	03/08/00
	Retail/Commercial	03/21/95	12/23/95	N/A	N/A	N/A	N/A
	Vacant	N/A	12/23/95	N/A	N/A	N/A	N/A
	HDSFR	N/A	03/12/96	N/A	N/A	N/A	N/A
	Transportation	N/A	12/23/95	N/A	N/A	N/A	N/A
	Light Industrial	N/A	02/20/96	N/A	N/A	N/A	N/A

It appears from the table that in a number of instances, peak fecal coliform counts occurred at different monitoring stations in different parts of the county during the same storm. Further, in 1995-96, the highest fecal coliform readings at five stations coincided with the largest storm of the season. Also, in 1996-97, the highest fecal coliform readings at two stations coincided with the first storm of the season greater than 0.1" rainfall. These observations suggest that peak fecal coliform levels may be related to regional hydrologic conditions.

4.2.3 Stormwater Toxicity

Two studies required by the 1996 Municipal Stormwater Permit examined stormwater toxicity. The Santa Monica Bay Receiving Waters study examined water column and sediment toxicity impacts on Santa Monica Bay from stormwater from Ballona and Malibu Creeks. The Southern California Coastal Waters Research Project (SCCWRP), the University of Southern California, and the University of California Santa Barbara were the principal investigators. In addition, dry and wet weather toxicity tests were performed on the Los Angeles and San Gabriel Rivers in 1997-98 and 1998-99. This testing was performed by the Southern California Coastal Waters Research Project. Toxicity was measured as impairment to sea urchin fertilization.

An Executive Summary of the Bay Receiving Waters study is included in Appendix C. Major findings of the stormwater toxicity studies (SCCWRP, 1999) are repeated below:

- Virtually every sample of Ballona Creek stormwater tested was toxic to sea urchin fertilization.

- The first storms of the year produced the most toxic stormwater in Santa Monica Bay during the study.
- The toxic portions of the stormwater plume were variable in size, extending from 1/4 to 2 miles offshore of Ballona Creek.
- Surface water toxicity caused by unidentified sources was frequently encountered during dry weather in Santa Monica Bay.
- Zinc was the most important toxic constituent identified in stormwater in Santa Monica Bay, but zinc concentrations in the toxic portion of the discharge plume were usually below levels shown to cause toxicity in the laboratory.
- Copper and other unidentified constituents may also be responsible for some of the toxicity measured in Santa Monica Bay.
- The measured concentrations of zinc and copper in Ballona Creek stormwater were estimated to account for only 5% - 44% of the observed toxicity.
- The fate of most stormwater constituents discharged to Santa Monica Bay is unknown.
- For two years in a row, wet weather toxicity was significant in the Los Angeles River. Dry weather toxicity was significant the second year, but not the first.
- For the San Gabriel River, wet weather toxicity was significant the first year, but not the second. Dry weather toxicity was not significant either year.
- For both rivers, wet weather toxicity was higher for the first storm tested, suggesting a seasonal “fist flush” phenomenon for toxicity.

4.2.4 Contaminated Sediments and Total Suspended Solids

Sea floor habitat and sediment contamination were studied in the Santa Monica Bay Receiving Waters study and were investigated by the Southern California Coastal Waters Research Project. Major findings of the sea floor habitat and sediment contamination study (SCCWRP, 1999) are repeated below:

- The sea floor is where stormwater particles, and associated contaminants, eventually settle.
- The sediments on the sea floor can accumulate runoff inputs over an entire storm, over several storms, or over several seasons.
- Sediments offshore of Ballona Creek generally had higher concentrations of urban contaminants, including common stormwater constituents such as lead and zinc.
- Sediments offshore of Ballona Creek showed evidence of stormwater impacts over a large area.
- Sampled biological communities offshore of Ballona Creek were similar to those offshore of Malibu Creek. Both areas had comparable abundance and similar species composition.
- Sampled biological communities offshore of Ballona and Malibu Creeks were also similar to background reference conditions established in previous studies of southern California.

The County of Los Angeles Department of Public Works has also participated on the Los Angeles Basin Contaminated Sediment Task Force. The management committee of the Task Force is comprised of the U. S. Army Corps of Engineers, the U.S. Environmental Protection Agency (Region IX), the California Water Quality Control Board (Los Angeles Region), and the California Coastal Commission. One of the goals of the Task Force is to promote and implement region-wide efforts at source reduction through watershed management. The Task Force, in its Long Term Management Strategy Action Plan (no date), states:

- Informal surveys of potential users and past projects suggest that the major sources of contaminated dredge material will continue to be Marina del Rey, the ports of Los Angeles and Long Beach, and the mouth of the Los Angeles River.
- Some of the sediments dredged from these harbors contain elevated levels of heavy metals, pesticides, and other contaminants. In most cases, the concentrations of these contaminants do not approach hazardous levels.

The Corps of Engineers, in a draft study (2000) sought to identify possible inland sources of contaminated sediments in the Ballona Creek watershed by sampling dry weather sediments in the bottom of Ballona Creek and major tributaries. The draft study found:

- Four of 21 sites were without any chemical concentration exceeding the National Oceanographic and Atmospheric Administration's "Effect Range-Low" (ERL) values: storm drain Bond Issue Project 9408, Project 425, Ballona Creek at Sawtelle Blvd., and Centinela Channel.
- Sediments on the bottoms of storm drain Bond Issue Projects 648, 51, 494, and 503 ranked by dry weight most consistently as the most contaminated sites with respect to metals and polycyclic aromatic hydrocarbons (PAHs).
- The two areas of the main Ballona Ck. channel that ranked, by dry weight, as most contaminated and exceeding ERLs were just downstream of Madison Ave. and Fairfax Ave.
- With respect to the potential for contamination from PAHs, sites in Ballona Ck. at Pickford St. and Fairfax Ave., Higuera St. drain, Projects 51 and 3867, and Culver City Acquisition and Improvement District No. 4 drain appeared most contaminated.
- Bed load sediment in the major tributary drains of Sepulveda and Centinela Channels were among the least contaminated samples.
- According to a Corps geographic information system used to model unit aerial loading, the area within the Ballona Ck. drainage area of expected highest stormwater loading of metals, oil, and grease extends from Hollywood to Culver City in a 1- to 2-mile wide, 5- to 6-mile long strip parallel and east of the San Diego (I-405) Freeway.

In an effort to analyze the presence of PAH in stormwater, Los Angeles County Public Works lowered the detection limit of semi-volatile organics in stormwater samples in the 1999-2000 season by using modified EPA method 625 (see Table 3-1). An analysis of stormwater mass emission mean concentrations (Table 4-6b) shows that two PAH compounds, phenanthrene and pyrene, exceeded the California Ocean Plan objective at the Malibu Creek station. No other PAH compound exceedences appeared through this comparison.

Given the connection between contaminated sediments and suspended solids (Stenstrom et al, 1997, in U. S. Army Corps of Engineers, 2000), we calculated suspended solids loadings at the five mass emission monitoring stations from 1994 to present (Table 4-10 and Fig. 4-5a) where data was available. The data shows that the Los Angeles River is the largest contributor of suspended solids. This finding is expected because the L. A. River drainage area is the largest monitored watershed (825 square miles at the monitoring station). However, during the El Niño season of 1997-98, suspended solid loading was disproportionately higher than Ballona Creek loading (88.8 square miles at the monitoring station). It should be noted, however, that the Ballona Ck. monitoring station was out of service during February of 1998.

Total suspended solids were high during the 1999-2000 storm season at the vacant land use site. This may have been due to modifications to the Sawpit Dam located upstream of the sampling station.

4.2.5 Comparison of Mass Emissions Concentrations to the Ocean Plan, Basin Plan, and California Toxics Rule

Table 4-6a shows the list of constituents analyzed from the stormwater mass emission monitoring sites since 1994. Both the annual mean and median of the analyses of these constituents were compared to the water quality objectives outlined in the California Ocean Plan, the Los Angeles Basin Plan, and the California Toxics Rule. Stormwater bacteria indicators were compared to the standards in AB411. It should be noted that, except for bacteria indicators, there are no numerical water quality standards that apply to stormwater or nonpoint source pollution. Current federal and state numerical standards apply only to point source pollution, such as sanitary sewage, industrial and point source discharges to the ocean and other water bodies. Water quality standards described in the 1995 Los Angeles Region Basin Plan or the 1997 California Ocean Plan do not apply to stormwater runoff, and any exceedence of values should not indicate violation nor noncompliance with the plans. Furthermore, a direct comparison of the sampling results with the Ocean Plan standards cannot be made since the results presented in the table are detected values before dilution, a factor allowed by the Ocean Plan.

Table 4-6b shows those constituents whose annual mean or median virtually exceeded the three objectives described above. For bacteria indicators, the log mean of the Most Probable Number per 100 ml was compared to the objectives of AB411. The table shows that the bacteria indicator standards were exceeded at every monitoring station where sampled for every year. The next most prominent virtual exceedences occurred with total and dissolved copper and bis (2-ethylhexyl) phthalate, followed by turbidity, total zinc, and total lead. The table also shows that 1997-98, the El Niño season, contributed the most virtual exceedences at all monitoring stations except Coyote Creek. Finally, the table shows that the Los Angeles River produced the most virtual exceedences of any other mass emission monitoring station.

4.2.6 Loading

The above discussion points to dissolved zinc and copper and total suspended solids as constituents worthy of further examination. If these are important constituents, it would be helpful to look at what watersheds are producing the greatest amounts of these constituents. A loading analysis, that is pounds of constituent per season, would make this indication. To calculate annual loading, the annual mean concentration of the constituents of interest are multiplied by the annual volume of runoff measured at each mass emission station. Loading results are shown in Table 4-10 and Figures 4-5a through 4-12.

As expected, loading was greatest during 1997-98, the El Niño season. This analysis indicates that the Los Angeles River delivered the highest loadings of total suspended solids (approx. 220,000 tons), dissolved copper (approx. 28 tons), total copper (approx. 40 tons), dissolved zinc (approx. 170 tons), and total zinc (approx. 230 tons). Further, it appears that Los Angeles River loading for the metals is disproportionate by drainage area to the other watersheds.

Total and dissolved zinc loading is also prevalent among unmonitored watersheds. The Dominguez Channel/L. A. Harbor watershed contributed the highest loadings for dissolved zinc (approx. 2.3 tons) and dissolved copper (approx. 30 tons) and was the highest for each year.

Loading calculations from unmonitored watersheds were accomplished by a GIS model (Table 4-11 and Figures 4-16 through 4-19). Comparison of loadings between monitored and unmonitored watersheds should not be made at this time because the model is not fully calibrated.

4.2.6.1 GIS Model

To assist in implementing this requirement, the Department developed a GIS application called the Pollutant Loading Model. A brief description of the model follows:

Hardware Requirements

- IBM-compatible, running Windows NT 4.0 or Windows 95
- 8 MB hard disk space (data/project on network); 600MB hard disk space (local)
- 64 MB RAM or higher

Software Requirements

- ArcView 3.1
- Spatial Analyst 1.1 for ArcView

Data Requirements

Geographic -

- Thomas Brothers Maps® data sets, County of Los Angeles
- Southern California Association of Governments Land Use
- Watershed Management Area Boundaries
- Rain gage locations and depths
- Watershed sub-basin boundaries
- Municipal Boundaries
- Water Quality Monitoring Station locations

Tabular -

- Rain gage data for each rainfall event
- Event Mean Concentration data

The Pollutant Loading application computes total pollutant loading for selected pollutants originating in user-defined watersheds or political boundaries. It draws upon many existing data sources, such as predetermined drainage subbasins, land use, historical and event rainfall data, water quality monitoring station results, and multiple underlying geographic data including political boundaries, natural boundaries, census tracts, forest boundaries, streets, and drains.

The user is given the option of hand-digitizing a study area or graphically selecting a predetermined drainage subbasin, monitoring station watershed, city, or other municipal boundary to use as a study area. The user can also locate an area of interest by typing an address or selecting a Thomas Brothers Maps® page.

The user selects a rainfall event from historical records. Rainfall data comes in the form of a previously processed grid of the user-selected storm event or as a rain gage data file, in which case, the model will prepare a rainfall grid using the Spatial Analyst extension. There is also an option to use average annual rainfall.

The application uses the rainfall data to calculate the amount of runoff, based on the imperviousness of the land use polygons it intersects. See equations used at the end of this Section.

The user then has the ability to choose the pollutants for the study from over 257 constituents. The Water Quality data comes from over 24 monitoring stations the County has operated at some point since the 1994-95 storm season. The user can quickly select constituents from pre-classified groups such as General Minerals, Heavy Metals, Pesticides, etc. By default the model will select the 25 pollutants of concern (made up of 61 constituents) listed in the NPDES permit.

The model will then tabulate total pollutant load for the study area using previously calculated Event Mean Concentrations of the selected pollutants. A report of the results is generated in Crystal Reports. The application also produces maps as ArcView layouts showing the area of study, rainfall isohyets, landuse distribution, rain gage locations and values.

Equations Used

- Runoff Volume = (Rainfall Volume)*(Runoff Coefficient)
  Where:
  Runoff Coefficient = (0.8*Imperviousness) + 0.1
- Load = (Pollutant concentration)*(Runoff Volume)

Assumptions and Limitations

- An imperviousness value used for the calculations is associated with 104 different landuse categories.
- The 104 SCAG land use categories have been aggregated into 34 categories covering 100% of the County.

- Water quality data collected from 8 different landuse monitoring stations yields Event Mean Concentration (EMC) values. The remaining landuse categories (34-8 = 26) use assumed EMC values based on their association with the 8 monitored landuse types.
- All polygons of the same landuse type are assumed to have the same EMC value regardless of their spatial location within the county.
- Annual pollutant loadings use previously calculated seasonal EMCs for their calculation.
- Rainfall grid cell sizes are 500 feet by 500 feet. Rainfall depth does not vary within the grid cell.
- The model does not account for variation over time in soil permeability which influences surface runoff in undeveloped watersheds. In other words, a given coefficient of discharge for a particular land use type will not change regardless of previous soil conditions (saturated soil versus dry soil)

The primary operations that are inherent to both observed and modeled methods are described below.

Comparison of Observed and Modeled Load Calculation Methods

ITEM	OBSERVED METHOD	MODEL CALCULATIONS
STORM RUNOFF VOLUME	Flow rate taken directly from stream gage data and integrated over duration of storm to develop runoff volume. Note that this parameter includes base flow and storm runoff. Calculations can be made to estimate a base flow and separate it from the observed runoff.	Rain gage rainfall depths are used to prepare a rainfall grid surface. Rainfall grid cells are 500' x 500'. Equations: (1) Runoff coeff. = (0.8 x Imperviousness) + 0.1 (2) Rainfall volume = (Rainfall depth) x Area (3) Runoff volume = (Rainfall vol.) x (Runoff coeff.)
POLLUTANT EVENT MEAN CONCENTRATION (EMC)	Flow composited samples obtained at the mass emission monitoring sites are analyzed by the lab. Resulting pollutant concentrations are EMCs.	(1) The entire county is comprised of 34 general land use types. Storm runoff from the 8 most significant types is flow-weight sampled by automated equipment. The monitored watersheds of the eight significant types are chosen to represent typical examples of that land use. (2) Water quality results from the 8 monitored land use stations are assigned to the remaining 26 unmonitored land use types based on similarities of land use. (3) Any given land use type is assumed to yield the same EMC anywhere in the county (i.e. a given polygon defined as Single Family Residential (SFR) is assumed to yield the same EMC as any other SFR polygon in the county).
POLLUTANT LOAD	Observed concentration (EMC) multiplied by observed runoff volume.	Observed and assigned concentrations (EMC) for each land use multiplied by the modeled runoff volume for each land use summed within the area of study.

The model does not take into account possible degradation or adsorption of the pollutant as it is transported downstream. These results therefore should not be taken as absolute; rather, they should be used for unmonitored watersheds or smaller portions of monitored watersheds for comparative purposes only.

4.2.7 Constituents of Concern

Table 4-6b includes sixteen chemical constituents that were identified from the comparison of mass emission annual concentrations to the objectives of the California Ocean Plan, the Los Angeles Basin Plan, and the California Toxics Rule. Two organophosphate pesticides, diazinon and chlorpyrifos, are also included in Table 4-6b because of their identification of stormwater toxicity in other independent studies (Lee, 1998). Indicator bacteria (total coliform and fecal coliform, streptococcus, and enterococcus) are also included due their exceedence of AB411.

As of yet, Total Maximum Daily Loads (TMDLs) are not part of the Los Angeles Municipal Stormwater Permit. However, constituents identified by the 303d list that were not already identified through the comparison process, namely nutrients, are also included in Table 4-6b. It should be noted that there were no virtual exceedences by nutrients (compounds of nitrogen and phosphorus) of the three water quality objectives. Further, a report by the Las Virgenes Municipal Water District (May, 2000) found that beneficial use impairment due to algae growth is not a problem during storm season in Malibu Creek.

4.2.8 Identification of Possible Sources

With the identification of dissolved zinc and copper as stormwater toxicants in the Santa Monica Bay receiving water study (SCCWRP, 1999), and the implication of suspended solids (U. S. Army Corps of Engineers, 2000), it is helpful to look at land use and critical source runoff quality data (Tables 4-12 and 4-15 and Figures 4-1 and 4-3) to see if any particular land uses or industries could be singled out as notable or significant for those constituents. Figures 4-22 and 4-23 also show which constituents were prevalent at which land use.

Light industrial, transportation, and retail/commercial land uses displayed the highest median values for total and dissolved zinc, with light industrial the highest at about 300 Fg/l for dissolved zinc and about 360 Fg/l for total zinc. Runoff concentrations from the remaining land use types (high density single family residential, education, multifamily residential, and mixed residential) were significantly less.

Light industrial and transportation land uses displayed the highest median values for total and dissolved copper, with transportation the highest at about 28 Fg/l for dissolved copper and about 40 Fg/l for total copper.

Median concentrations of total suspended solids were highest coming off of the light industrial land use category, at about 130 mg/l.

These land use observations, particularly from the light industrial and retail/commercial categories, can be narrowed down by looking at the stormwater zinc, copper, and suspended solids sampled under the Critical Source program. The critical source industries sampled to date fall under the following SCAG land use categories:

Critical Industry Land Use Types

Critical Source Industry	SCAG Land Use
Auto Dismantling (Wholesale Trade)	Heavy Industrial
Auto Repair	Retail/Commercial
Metal Fabrication	Heavy Industrial
Motor Freight	Transportation
Auto Dealerships	Retail Commercial

Table 4-15 and Figure 4-3 show the highest median value for total zinc (approx. 450 Fg/l), dissolved zinc (approx. 360 Fg/l), total copper (approx. 240 Fg/l), and dissolved copper (approx. 110 Fg/l) were produced at the fabricated metal sites (labeled “control”). This finding holds true for those critical source industries added and sampled in 1999-2000, namely motor freight and auto dealerships, which are discussed in the 1999-2000 annual monitoring report. However, levels for total and dissolved zinc did not appear to be significantly different between the industry types.

By contrast, levels for total and dissolved copper did appear significantly higher for the fabricated metals sites over the other critical industry categories. The highest median level for suspended solids was also produced at the fabricated metals sites, but no industry was significantly higher or lower than another for suspended solids.

Bacteria indicators were analyzed for the first time from the critical source sites in 1999-2000.

4.2.9 Best Management Practices for Critical Source Industries

In the 1999-2000 season, items of equipment called Best Management Practices (BMPs) were purchased by the County for installation at half of the companies from the auto dismantling, auto repair, and metal fabrication industries. These preventive-type BMPs took the form of good housekeeping and spill containment measures (Table 4-16). Each business owner agreed to be responsible for installing and using the BMPs. The County encouraged the business owners to utilize the BMPs during the storm season, but the County had no jurisdiction or control over how or when they were used.

Table 4-15 and Fig. 4-3 compare the results of those companies fitted with BMPs to those without. For total and dissolved zinc, the median concentration lowered or stayed nearly the same with the implementation of BMPs at the auto dismantling, auto repair, and fabricated metals industries. (For the auto dismantling and auto repair industries, the median actually increased slightly.) In none of the circumstances was the difference significant.

For total and dissolved copper, however, where the fabricated metal industry had displayed the highest median concentrations, levels were significantly reduced with the implementation of BMPs. The auto dismantling and auto repair businesses showed no significant difference.